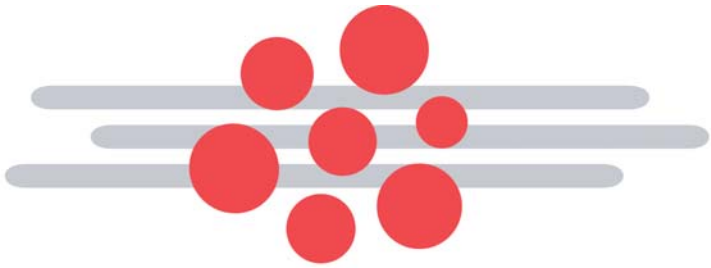
Fire Protection Assessment

Fire Hazard Analysis



Center for Functional Nanomaterials
Brookhaven National Laboratory

Project No. 05-R-321
March 2007

BNL Center for Functional Nanomaterials

Basic Energy Sciences

Fire Protection Assessment / Fire Hazard Analysis for the Center for Functional Nanomaterials (CFN)

At

Brookhaven National Laboratory (BNL)

Upton, New York

Prepared by:

Michael Kretschmann, PE **Date**
Fire Protection Engineer, BNL

Project Concurrence:

Michael Harrison **Date**
CFN Project Director, BNL

Project Review:

Joseph Levesque **Date**
Fire Protection Engineer, BNL

Conferred with: **Joseph Levesque – Fire Protection Group**
Martin Fallier – Plant Engineering
Robert Sabatini – Material Sciences
Ove Dyling – Plant Engineering
Michael Schaeffer – CFN Project Manager
Steven Hoey – CFN

March 2007

BROOKHAVEN NATIONAL LABORATORY

Center for Functional Nanomaterials
Brookhaven National Laboratory

1 TABLE OF CONTENTS

2 OVERVIEW AND REVIEW COMMENTS

2.1 Purpose

The purpose of this assessment is to comprehensively and qualitatively assess the risk from fire within the Center for Functional Nanomaterials (CFN) to ensure DOE fire safety objectives are met. DOE fire protection criteria are outlined in DOE Order 420.1[1], Chapter 4. The fire protection assessment includes identifying the risks from fire and related hazards (direct flame impingement, hot gases, smoke migration, fire-fighting water damage, etc.).

2.2 Summary

The CFN is expected to be fully operational in April 2008, will be housed in a building consisting of offices and laboratories, located near the National Synchrotron Light Source (NSLS). The centerpiece of the facility will be composed of five state-of-the-art equipment facilities, and a Theory and Computation Center.

The CFN facilities will include advanced capabilities in nanopatterning, transmission electron microscopy, nanomaterials synthesis, ultra-fast laser sources, and powerful probes to image atomic and molecular structure, together with clean rooms and other support instrumentation.

This assessment and Fire Hazard Analysis (FHA) are based on information supplied by the CFN staff, the design and construction team, site surveys and a review of the shop drawings and as-built drawings. This assessment and FHA demonstrates the achievement of a reasonable and equivalent level of fire safety that meets DOE improved risk objectives.

The “Clean Room Laboratory Suite” on level 1 has only a smoke detection system in the dedicated return air ductwork. DOE/EP-0108 requires a smoke detection protection in the room area for assets with a value over 1 million dollars. The value of the equipment in the clean room exceeds this monetary value. However there is no detection in the room due to the high velocity laminar air flow through the ceiling down to the return air ductwork located on the walls near the floor. A smoke detector in the

[1]US Department of Energy Order No. 420.1, Facility Safety, 11/16/95

room area would not be practical because of the low probability on the detector being in the path of the air flow to sense a smoke condition.

The Clean Room Laboratory Suite is defined as “Business Occupancy” by the Building Code of New York State (BCNYS) and as “Industrial, General Purpose” by National Fire Protection Association (NFPA). If this area in the future needed to be reclassified as “H-5” occupancy per BCNYS in order to use the types and quantities of flammable gases associated with Clean Rooms then a redesign of the space will be required to address both BCNYS and NFPA Standard 318 “Standard for the Protection of Semiconductor Fabrication Facilities,” requirements.

2.3 Review Comments

The following are review comments from the Preliminary Fire Hazard Analysis dated December 2004 and the current survey of the building including shop drawings and as-built documents. Review comments that were incorporate in the construction have been eliminated. The design team’s resolution to each of the December 2004 design comments are noted in Appendix A.

2004-735-02. Vital Record backup procedures should be verified for the vital records being generated by the experiments to make sure it conforms to BNL subject area.

2007-735-01. Plant Engineering and Operations are required to document the procedure for shutting off and restricted movement of Pyrophoric materials in the building during all sprinkler system impairments.

2007-735-02. Plant Engineering shall produce a Inspection, Testing and Maintenance program for the Lightning Protection system in conformance with National Fire Protection Association Standard 780 requirements.

3 SCOPE

The Center for Functional Nanomaterials serves as the nucleus of an integrated BNL program in nanoscience. It will facilitate major new directions in BNL's materials and chemical research programs, and greatly expand the capabilities available to a national

user base, and thereby increase our university and industrial interactions. It will enable us to focus the energies of organizations within Brookhaven doing complementary, interdisciplinary work, including the Chemistry Department, the Materials Science Department, Condensed Matter Physics, the Instrumentation Division, the National Synchrotron Light Source Department, and the Biology Department. The Center will also integrate BNL's unique capabilities in a broad range of synchrotron techniques, hard and soft x-ray scattering and spectroscopy, with new material and nanofabrication capabilities at BNL. The Center will serve as a focal point for collaborations, enabling studies of functional materials at the nanoscale with academia and private industry, particularly in the Northeast, thereby catalyzing a new approach to materials research at BNL.

This assessment and Fire Hazard Analysis (FHA) are based on information supplied by the CFN staff, the design and construction team, site surveys and a review of the shop drawings and as-built drawings.

4 LOCATION

The Center for Functional Nanomaterials is located in the central east region of Brookhaven National Laboratory (BNL). The building will be bounded by Brookhaven Avenue on the North, Groves Street on the East, Bell Avenue on the South, and Rochester Avenue on the West. The building is setback a minimum of 100 feet on all sides from roadways and there are no contiguous buildings. BNL is a 5,000 acre site owned by the Department of Energy and operated by Brookhaven Science Associates. BNL is located in Upton, New York.

5 CONSTRUCTION

5.1 Building Layout and Size

The CFN structure is a two-story building of approximately 94,500 square feet, housing clean rooms, wet and dry laboratories, office space for BNL staff and users, and conference rooms. The two floors are open in three areas: the lobby area, and the two unenclosed stairs.

On the first floor there are laboratory suites, offices, conference rooms, toilets, an electrical room, utility entrance room, loading dock, and hazardous material storage areas. The gross floor area is 51,067 square feet.

On the second floor there are offices, conference rooms, toilets, mechanical rooms, and a meeting room area that can be configured to support more than 50 people. The gross floor area is 43,433 square feet.

5.2 Occupancy Classification

The Clean Room Laboratory Suite is classified as “Business” occupancy by Building Code of New York State (BCNYS). NFPA classifies the same areas as “Industrial, General Purpose” occupancy. The Clean Room Laboratory Suite in the future may be upgraded to “H-5” occupancy per BCNYS, however this FHA will not address the this possible upgrade.

Chemical Waste Storage Room (1034), Pyrophoric Bunker (1L48), and the Toxic and Corrosive Storage Room (1032) all located on level 1 by the loading dock are classified by BCNYS as “High Hazard Group H-3” occupancy.” NFPA classifies these areas as “Storage, High Hazard” occupancy.

The Flammable Storage room (1033) on level 1 by the loading dock is classified by BCNYS as “High Hazard Group H-2” occupancy.” NFPA classifies this area as “Storage, High Hazard” occupancy.

The Seminar rooms (2013, 2015) on level 2 are classified by BCNYS as “Assembly, A-3” occupancy. NFPA 101 classifies these areas as “Assembly” occupancy.

The Building Services Room (1035) and Main Electrical Room (1037) on level 1 and the mechanical spaces on level 2 not associated with the Clean Room Laboratory Suite are classified by BCNYS as “Business” occupancy.” NFPA classifies this area as “Industrial, Special Purpose” occupancy.

Except for those areas noted above the remainder of the CFN is classified by BCNYS as “Business” occupancy. NFPA classifies the same areas as “Industrial, General Purpose” occupancy.

5.3 Control Areas

The building uses the concept of control areas as defined by BCNYS and NFPA 5000 to take advantage of increased allowable quantities of hazardous materials to be used, processed or stored in the building. The allowable quantities are outlined in Table 34.1.3.1 of NFPA 5000 and Table 307.7(1) of BCNYS. Since the building is fully sprinklered the quantities in each table can be double by the exceptions noted in each code.

There are four control areas designated in the building. Control Area 1 (CA-1) encompasses areas on levels 1 & 2. Control Area 2 (CA-2) is a laboratory suite located on level 1 in the Northeast side of the floor between column lines C & F and 2 & 6. Control Area 3 (CA-3) is a laboratory suite located on level 1 in the Northwest side of the floor between column lines G & L and 2 & 6. Control Area 4 (CA-4) is a laboratory suite called the Clean Room Laboratory Suite is located on level 1 in the Southwest corner of the floor between column lines G & N and 11 & 13.

The fire wall rated between control areas will be 1 hour as required by both BCNYS and NFPA.

5.4 Building Construction Fire Ratings

The overall building construction classification is “IIB” for BCNYS and Type II - 000 for NFPA standard 5000 “Building Construction and Safety Code”.

5.4.1 Floor and Roof Ratings

The structural floor ratings in the second floor are not uniform. The floor is rated for 2 hours in the areas above two of the laboratory suites and the corridor adjacent to the Clean Room Laboratory Suite. One hour rated floors above a portion of the south side of the floor between column lines 10 &11, and below the level 2 meeting room area. The rest of the floor structural steel is not be rated.

The roof is a combination of a large raised seam metal roof and a non combustible flat roof. The roofs are not fire rated.

5.4.2 Column Ratings

The structural column fire ratings in the building are not uniform. Columns are rated for 2 hours in the areas within two of the laboratory suites and the corridor adjacent to the Clean Room Laboratory Suite. One hour rated floors above a portion of the south side of the floor between column lines 10 &11, and below the level 2 meeting room area. The rest of the columns are not rated.

5.4.3 Wall Ratings

Interior wall fire ratings in the building are not uniform. Two hour rated walls in the areas enclosing the Flammable Storage room on level 1. One hour rated walls enclosing the elevator shaft, two enclosed egress stairs, three of the laboratory suites on level 1, the elevator equipment room on level 1, three hazardous storage rooms on level 1, corridor surrounding the Clean Room Laboratory Suite on level 1, three shafts between columns 10 & 11 on level 2, and the meeting room area on level 2. The rest of the walls are not rated.

Exterior wall fire ratings in the building are not uniform. Two hour rated 2 hours in the areas enclosing the Flammable Storage room on level 1. One hour rated walls enclosing three of the laboratory suites on level 1. The rest of the walls are not rated.

5.4.4 Ductwork Ratings

Exhaust ductwork fire ratings in the building are not uniform. Two hour enclosures for two of the laboratory suites CA-2 & CA-3 are provided from the second floor slab penetration to the exterior. All other exhaust ductwork are not rated.

5.5 Mechanical & Electrical Systems

Each control area has their own dedicated air handling units (AHU) to supply and exhaust air. There are five air handling units for CA-1, one AHU for laboratory suite CA-2, one AHU for laboratory suite CA-3, and 8 AHU’s for the Clean Room Laboratory suite CA-4.

Exhaust fans are provided for fume hoods, general laboratory exhaust, toilet rooms, mechanical and electrical rooms, process equipment, hazardous storage, and other areas requiring exhaust.

Laboratories have individual fume hoods that have a negative pressure relationship to adjoining areas. For flexibility, cost effectiveness, and for allowing heat recovery and stand-by capability, laboratories have central manifolded exhaust fans. Risers are connected to an exhaust manifold in the penthouse.

There is a centralized emergency generator system located on a pad outside the back of the facility. The fire alarm system, detection systems, emergency lighting, elevator system, and exhaust fans for the hoods.

6 FIRE PROTECTION

Fire protection systems that provide protection to full or segmented portions of this facility can be classified in four categories; Automatic Fire Suppression Systems, Fire Alarm, Automatic Detection Systems, and Fire Extinguishers. The following is a description of the installed systems in the Center for Functional Nanomaterials.

6.1 Automatic Fire Suppression Systems

Automatic Fire Suppression Systems consisting of Sprinkler, Standpipe, and Detection Systems are provided in this facility. Sprinkler and Standpipe systems will be supplied by the Site Water System via the Building Water Supply and Fire Department Connection. A description of each of these systems is outlined below.

6.1.1 Site Water System

BNL has a combination domestic and fire protection water supply system. The system is supplied by several deep wells and is stabilized by two elevated water storage tanks (one 1 million gallon and 300,000 gallon capacity). The wells have electric primary drivers and a limited number have backup internal combustion drivers. The system can sustain three days of domestic supply and a maximum fire demand (4,000 GPM for 4 hours) for BNL with two of the system's largest pumps out and one storage tank unavailable. The piping distribution network is well gridded. The distribution system in the vicinity of the Center for Functional Nanomaterials has static supply pressure of 54 PSI at low elevated tank levels. The water supply system in the area can supply about 2850 GPM at 20 PSI (based on the Water Distribution Model Analysis developed by Fire Protection Engineering Group during the summer of 2004.)

Frost Proof Fire hydrants are provided within 300 ft. of each facility. Frost proof hydrants are needed since the frost line extends to 4 feet below the surface in the winter. BNL and the local Suffolk County Fire Departments use National Standard Thread couplings.

BNL's Plant Engineering Division maintains the water supply system. BNL's Fire/Rescue Group conducts valve inspections on the distribution system to ensure reliability of firefighting water supplies.

6.1.2 Building Water Supply, and Fire Department Connection

CFN has two redundant 8 inch cement lined ductile iron supply feeds connected to the site water distribution system. One feed is connected to the 10 inch looped transite main along Rochester Avenue. The second feed is connected to the 6 inch looped transite main along Bell Avenue.
The supply feeds are installed a minimum of 4 feet below the surface to be below the frost line. The frost line at Brookhaven National Laboratories is less than 4 feet. The mains are run in separate paths until they are within 40 feet of exterior wall of the building. When the feeds are less than 40 feet from the exterior wall they run parallel to each other at a separation of 5 feet.

Each supply feed enters the Building Services Room (1035) located on the first floor in the south west corner of the building. The room has an exterior door which can be used for Fire Department access. Each feed main has 6 inch Underwriter's Laboratories (UL) listed and Factory Mutual Insurance (FM) approved double check valve assemblies. The double check valve assemblies are located in the Building Services Room (1035). On the inlet and outlet of the double check assemblies are 6 inch OS&Y valves with tamper switches. This configuration meets the current Building Code of New York State (BCNYS) requirement.

Fire Department Connection (FDC) is located on the north side exterior wall of the CFN adjacent to the front entrance. The nearest hydrant is less than 300 feet from the fire department connection as required by DOE. The two 2 ½ inch outlets on the FDC conform to National Standard Thread couplings standards. The piping between the FDC and the supply side of the Alarm Valve Assembly is 4 inch. The pipe connects to the discharge side of the Alarm Valve Assembly.

6.1.3 Sprinkler Systems

In the CFN automatic sprinkler system protection, conforming to NFPA 13 “Standard for the Installation of Sprinkler Systems,” is provided throughout the building. There will be three sprinkler system zones (first floor, first floor elevator room and shaft, and the second floor).

6.1.3.1 Alarm Valve Assembly

An Alarm Check Valve assembly is located in the Building Services Room (1035) of the CFN. It will be UL listed and FM approved. The alarm check has a water motor gong that will be placed on the exterior of the building per the requirements of NFPA. On the discharge side of the alarm check valve are two water flow switches for the two sprinkler zones in room 1053. The third water flow switch is in the first floor elevator machine room ceiling. The flow switches will provide the required alarm signals for flow activation to the building fire alarm panel.

6.1.3.2 Wet Pipe Sprinkler Systems

The wet pipe sprinkler systems in the CFN are hydraulically sized. Two ordinary hazard design densities will be provided. The Clean Room Laboratory suite and the four hazardous storage rooms on level 1 will be calculated with an Ordinary Group II density of 0.2 GPM per square foot sprinkler over the most hydraulically remote 3000 sq. ft. For all other areas in the building an Ordinary Group I density of 0.15 GPM per square foot sprinkler over the most hydraulically remote 2500 sq. ft. will be utilized.

The sprinkler heads are spaced to ordinary hazard except for the four hazardous storage rooms on level 1 are spaced to extra hazard requirements of NFPA 13. Total inside and outside hose requirement of 250 GPM for ordinary hazard has been added to the calculations.

6.1.4 Fire Standpipe Systems

An automatic wet standpipe system conforming to NFPA 14 is not required by code. As request by the BNL Fire/Rescue Group, hose valves will only be located on each floor inside the two enclosed stairs (stairs 2 & 4). A hose valve shall also be provided

in stair 2 at the entrance to the roof. The class of hose valves, as listed in the BCNYS, will be “Class III” (2½ inch valve with a 2½ inch by 1½ inch reducer). The hose valves will be connected to the automatic sprinkler system zones.

6.2 Fire Alarm Systems

The facility will have a fire alarm system that is connected to the Site fire Alarm system. The two systems are as follows.

6.2.1 Building Fire Alarm System

The CFN has a building fire alarm system consisting of a fire alarm panel, manual stations, and visual and audio alarm notification devices conforming to NFPA 72 “National Fire Alarm Code” of 2002. The fire alarm panel is located in the lobby area on the north side of the building on the first floor. The fire alarm panel will be UL listed and FM approved. The panel is connected to the Site Fire Alarm System via the fiber cable in the site underground telecommunication infrastructure network.

6.2.2 Site Fire Alarm System

Brookhaven National Laboratory provides central fire alarm station coverage by an Underwriter Laboratory listed multiplexed Site Fire Alarm System. The system is a Wormald System 1000; installed in 1987 (Wormald is now known as Grinnell Fire System). The system complies with the requirements of NFPA 72 for a Style 7D System.

The system uses the existing site telephone cable plant. RS232 signals are sent via full duplex line drivers. Each fire alarm panel has two channels connected to the Central Station. The panels are divided into 7 communication "loops." The system can monitor more than 20,000 points. It is currently monitoring 3,800 points. Response time from alarm at the panel to alarm indication at the Central Station is less than 90 seconds, which is within the 90 seconds allowed by NFPA 72.

The main console is at the Firehouse, Bldg. 599. This station is manned 24 hours a day seven days a week (24/7) and monitors all fire alarm signals, trouble and communication status alarms. A satellite station also manned 24/7 is provided at Safeguards and Security, Bldg. 50, and receives only the fire alarm signals.

6.3 Automatic Detection Systems

Automatic detection systems protection is provided in portions of the building. Heat detection protection is provided in the four hazardous storage rooms on level 1. Smoke detection protection is provided in return ductwork, both sides of the doors into the enclosed egress corridor on level 1, elevator lobbies for recall, ceiling area above the lobby area floor opening and all the laboratory areas except the “Clean Room Laboratory Suite”.

The “Clean Room Laboratory Suite” on level 1 has only a smoke detection system in the dedicated return air ductwork. DOE/EP-0108 requires a smoke detection protection in the room area for assets with a value over 1 million dollars. The value of the equipment in the clean room exceeds this monetary value. However there is no detection in the room due to the high velocity laminar air flow through the ceiling down to the return air ductwork located on the walls near the floor. A smoke detector in the room area would not be practical because of the low probability on the detector being in the path of the air flow to sense a smoke condition.

6.4 Fire Extinguishers

Dry Chemical fire extinguishers are installed throughout the facilities in accordance with NFPA 10. Extinguishers are Underwriter Laboratories listed. Use of additional specialized extinguishers will be determined during the experiment reviews for each laboratory.

7 FIRE HAZARDS

Fire hazard potentials are classified into four major categories; Building Materials, Special Occupancies, Exterior Hazard Exposure, and Natural Hazard Exposure. The following is an evaluation of the CFN for each category.

7.1 Special Occupancies

Special occupancies include: instrumentation and data processing equipment, vital and important records, trailers, cooling towers, electrical substations, flammable liquid and gas storage, cables and raceways, . The special occupancies of CFN are expanded upon in sections 7.1.1 and 7.1.7 below.

7.1.1 Instrumentation and Data Processing Equipment

DOE/EP-0108 has establishes monetary values for protecting Instrumentation and Data Processing equipment. Each monetary level requires either active or passive fire protection systems.

7.1.1.1 Sprinklers & Smoke Detection for Equipment Exceeding $1 M

DOE/EP-0108 section 403-1 paragraphs a. and b. requires automatic sprinkler and smoke detection protection for equipment exceeding $1 million dollars. The equipment in the Laboratories on level 1 falls into this requirement for detection. Most of the Laboratories have smoke detectors located on the ceilings. However the “Clean Room Laboratory Suite on level 1 do not have smoke detection systems protection on the ceiling. The “Clean Room Laboratory Suite” on level 1 has only a smoke detection system in the dedicated return air ductwork. There is no detection in the room due to the high velocity laminar air flow through the ceiling down to the return air ductwork located on the walls near the floor. A smoke detector in the room area would not be practical because of the low probability on the detector being in the path of the air flow to sense a smoke condition.

7.1.2 Vital and Important Records Storage

DOE/EP-0108 section 603 details requirements for protecting various types of records involved in the use of instrumentation and data processing equipment. CFN will have to determine the class of records produced and stored within the facility and make sure the proper level of protection is provided based on their record class. The four record classifications and the standard operation with the records are as follows.

Class 1 (Vital) Records are those records which are essential to the mission of an important program and which, if lost, could not be reproduced or obtained elsewhere. Records shall be duplicated immediately as a standard procedure: duplicates shall be stored in a separate fire area from that housing the originals, preferably in a separate building.

Class 2 (Important) Records are those records possessing a high value to the mission of an important program but which, if lost, could be reproduced or reconstructed with difficulty or significant extra expense. Records shall be

duplicated immediately as a standard procedure: duplicates shall be stored in a separate fire area from that housing the originals, preferably in a separate building.

Class 3 (Useful) Records are those records which could be readily replaced without presenting a great obstacle to prompt restoration of operations. Records, whenever practicable, shall be duplicated as a standard procedure: duplicates shall be stored in a separate fire area from that housing the originals, preferably in a separate building.

Class 4 (Nonessential) Records are those records which are unnecessary to accomplishment of the mission, and records which in accordance with prearranged plans and authorizations are eligible for destruction, or erasure of recorded data on media. In order to reduce the fire load records in this classification shall be destroyed or erased for reuse.

Review of the backup procedure of data collected as part of this program is out of scope of this Fire Hazard Analysis but will be a recommendation to ensure it is being adequately protected in accordance with DOE requirements (Comment 2004-735-02).

7.1.3 Trailers and Portable Structures

There are no trailers or portable structures associated with CFN.

7.1.4 Cooling Towers

There are no cooling towers associated with CFN.

7.1.5 Electrical Substations

The transformers and switch gear are arranged to meet the recommendations in Factory Mutual Loss Prevention Data Sheet 5-4 for fire protection. The transformers do not present an exposure hazard to the facility or each other.

7.1.6 Flammable Liquid & Gas Storage

The quantity of flammable gases and liquids in the facilities are less than the limits mandated by BCNYS Table 307.7(1) “Maximum Allowable Quantity per Control Area

of Hazardous Materials Posing a Physical Hazard." Use of flammable liquids will follow BNL ES&H Standards (found at https://sbms.bnl.gov/ld/ld08/ld08d481.pdf).

7.1.7 Cables and Raceways

High voltage, low voltage, control, and signaling cables will be segregated in accordance with NFPA 70 "National Electrical Code" requirements throughout the CFN. The cabling will be located in conduits, raceways and cable trays

7.2 Combustible Building Materials

No significant amounts of combustible building materials will be installed in this facility.

7.3 Exterior Exposure Hazards

Any exterior structure, area or piece of equipment that is subject to harmful effects from, or can cause harmful effects to; this facility is defined as an exterior exposure. Exterior exposures can be categorized as: elements outside of the facility, and as components of the facility.

7.3.1 Elements Outside of the Facility

The following is a summary of fire exposures to the CFN facility. All exposures are evaluated using Factory Mutual Data Sheet 1-20 "Protection against Exterior Fire Exposure."

7.3.1.1 North Exposures

Exposures to the North will be minimal. Building 515 will be over 200 feet from the CFN. Two Story building is constructed of non combustible construction and is fully sprinklered.

7.3.1.2 South Exposures

Exposures to the South will be minimal. Single story building 97 will be over 350 feet from the CFN and two story building 452 will be over 450 feet. Both buildings are combustible construction. Building 97 is fully sprinklered and building 452 has partial sprinkler protection and heat detection.

7.3.1.3 East Exposures

Exposures to the East will be minimal. The nearest exposure will be over 500 feet away.

7.3.1.4 West Exposures

Exposures to the West will be minimal. Single story building 185 will be over 350 feet from the CFN and single story building 464 will be over 450 feet. Both buildings are combustible construction and do not have sprinkler protection.

7.3.2 Components of the Facility

7.3.2.1 Exposures Between the Building and Transformers

The exposure between the two structures will be minimal. The exposed building is 60 feet north of the exposing transformers. The transformers yard exceeds the minimum 50 foot separation for any transformer with any fluid type or volume from a non combustible construction building (FM Data Sheet 5-4 Table 2a.)

7.4 Natural Phenomenon Hazard Exposure

Natural Hazards can be classified in five hazard categories: lightning, windstorm, wild fire, earthquake and flooding. The following is an evaluation for each category.

7.4.1 Lightning Potential

CFN has a listed lightning protection system installed on the roof. The lightning damage potential for the CFN is a concern based on NFPA 780 Appendix H "Lightning Risk Assessment "calculation. Following the Risk Assessment methodology the expected lightning frequency ($\mathbf{N_d}$) is greater than the tolerable lightning frequency ($\mathbf{N_c}$) (calculations shown in appendix B of this document). NFPA 780 recommends when ($\mathbf{N_d}$) is greater than ($\mathbf{N_c}$) that a lightning protection system should be installed.

Plant Engineering shall produce an Inspection, Testing and Maintenance program for the Lightning Protection system in conformance with NFPA 780 requirements. (2007-735-02)

7.4.2 Windstorm Potential

Based on the structural drawings the CFN is designed to meet the BCNYS, NFPA 5000 and Factory Mutual requirements for a building built on the BNL site for windstorm potential. CFN is designed to meet a basic wind speed of 120 MPH and wind importance factor of 1.0. The ground roughness exposure category for the CFN area is ‘Exposure B.”

7.4.3 Snow Load Potential

Based on the structural drawings the CFN is designed to meet the BCNYS and NFPA 5000 requirements for a building built on the BNL site for snow load potential. CFN is designed to meet 45 PSF ground snow load, snow importance factor of 1.0, and snow exposure factor of 0.9

7.4.4 Earthquake Potential

The seismic damage potential for this facility is classified as low based on a Natural Hazards analysis produced for the BNL campus titled “DOE Accelerator Order 5480.25 Implementation Plane for Brookhaven National Laboratory National Phenomena Hazards Evaluation” dated April 1994.

Based on the structural drawings the CFN is designed to meet the BCNYS and NFPA 5000 requirements for a building built on the BNL site for seismic potential. CFN is designed to one second period acceleration, short period acceleration, and seismic importance factor consistent with the BNL site.

7.4.5 Brush Fire Potential

The CFN is located in the central part of BNL. Based on the criteria presented for evaluating fire potentials from Wildland in the “BNL Wildland Fire Interface Survey Report,” dated August 2002, the trees and shrubs do not pose a potential exposure to the CFN. Established roadways provided engineered features that help protect the facility from a potential wild land fire. The roof systems will not ignite from burning brand produced in a brush fire.

7.4.6 Flooding Potential

Ground water runoff from a severe rainstorm will not be a concern for the CFN. The ground around the site will be graded away from the building. Flood potential from

bodies of water overflowing their normal levels is low for the BNL area. The flooding potential for this facility was classified as low in a Natural Hazards Analysis report produced for the BNL site, dated April 1994, titled “DOE Accelerator Order 5480.25 Implementation Plane for Brookhaven National Laboratory National Phenomena Hazards Evaluation.”

7.5 Toxic Fire Potential

There are no known materials in the CFN that, if involved in a fire, would result in a significant quantity of toxic material being created and released.

7.6 Biological Fire Potential

There are no known materials in the CFN that, if involved in a fire, would result in a significant quantity of toxic material being created and released

7.7 Radiation Fire Potential

Based on “The Brookhaven Center for Functional Nanomaterials Preliminary Hazards Analysis” there will be no radioactive materials used or stored in the CFN. However radiation generating devices will be used in the facility in some on the Laboratories. The devices, if involved in a fire, would not result in radioactive hazard being released.

8 PRE-FIRE AND EMERGENCY PLANNING

The BNL Fire Department will maintain a pre-fire plan book for this facility. A Local Emergency Plan will be maintained for the Center for Functional Nanomaterials. It will include actions to take with various alarms. Operator requirements will be documented in the CFN Department Operation Procedure Manual.

8.1 Protection of Essential Safety Class Systems

There is no essential safety class systems associated with this non-nuclear facility.

8.2 Protection of Vital Programs

The operations associated with this facility are not considered to be a DOE vital program. Therefore, no special fire protection precautions, beyond those that are generically described above, are required for this facility.

8.3 Protection of High Value Property

The majority of the dollar value is concentrated in the Laboratories. Within its “Control Area” the equipment in each of these laboratory are valued below $10 Million and loss potentials are acceptable for these area

8.4 Critical Process Equipment

A detailed inventory of critical process equipment was determined by the CFN department. The inventory lists replacement value, installation cost and delivery time of each item.

8.5 The Maximum Possible Fire Loss (MPFL)

Maximum Possible Fire Loss (MPFL) for this scenario is estimated to be in excess of $24 million. The MPFL of this scenario is less than the requirement of installing fire barriers to limit the damage to the facility if it exceeded the $25 million threshold mandated by DOE. The following is the detail behind the MPFL estimate. MPFL estimate is based on a fire in which active fire suppression systems fail (sprinklers, detection, and fire alarm). The following details the expect loss.

8.5.1 MPFL Scenario

In this scenario the worst case in all the buildings would be a flammable gas fire started in the service corridor in one of the Laboratory Suites that are in the middle of the building in Control Area 1. The fire remains undetected for a long period of time. The delay of notification to the fire department allows the fire to expand horizontally through openings in non rated partitions. Fire migrates into the ceiling and involves the contents within the ceiling to heat up and contribute to the spread of fire and smoke into adjacent spaces. Fire damage to the non fire rated level 2 structural steel framing and columns is moderate above the fire area. Smoke damage is moderate on level 1. On level 2, smoke damage is minor. Salvageable amount of the building contents is considered high.

8.5.2 MPFL Calculation

MPFL Calculation Summary

8.5.2.1 Replacement cost of construction, building systems & contents	$	20,000,000
8.5.2.2 Cost of upgrades due to code changes required for new construction	$	-
6.5.2.3 Cost of lost time	$	4,000,000
8.5.2.4 Environmental clean-up costs	$	-
8.5.2.5 Exposure damage to other buildings, structures and property	$	-
8.5.2.6 Liability damages	$	-
TOTAL	**$**	**24,000,000**

8.5.2.1 Replacement Cost of Building and Building Systems

The project cost estimate is $81 million. Assuming less than 25% loss the cost to reconstruct the portion of the CFN damaged in the scenario we will use $20,000,000.

8.5.2.2 Cost of Upgrades Due to Code Changes

There will be no cost to upgrade the Facility since it will be built to present building codes.

8.5.2.3 Cost of Lost Time

Assuming an experiment month lost during rebuilding and commissioning the damaged area. Assuming a cost for 2 years of lost time will be $4,000,000.

8.5.2.4 Environmental Clean-Up Costs

Toxic, biological, and radiation incidents resulting from a fire, including water runoff were deem to be minimal above. For this calculation we will assume no cost.

8.5.2.5 Exposure Damage to Other Buildings, Structures & Property

As described above the exposure potential to other buildings, structures and property is negligible. For this calculation we will assume no cost.

8.5.2.6 Liability Damages

Liability damage is defined as the costs associated with the effect of exposures. For this calculation it is assumed to be no cost.

8.6 Recovery Potential

Within the facilities of the Center for Functional Nanomaterials critical process parts are identified by the Department. Critical process parts are those items essential to the operations of the experiments that require a long lead-time for replacement. These spares are stored in a separate building, not subject to a common incident

8.7 BNL Fire/Rescue Group

The BNL Fire/Rescue Group is a full time, paid department. Minimum staffing is five firefighters and one officer per shift. The firefighters are trained to meet Firefighter Level III by International Fire Service Training Association standard, National Fire Protection Association (NFPA) Fire Fighter Level II standard, and (NFPA) Hazardous Material Technician Level and they are Suffolk County Certified Confined Space Rescuers.

The BNL Fire/Rescue Group also provides emergency medical services to an on-site population of 3200 people. Minimums of two members per shift hold New York State "Emergency Medical Technician - D" certifications ("D" is for defibrillation). Normally all five firefighters have EMT status. The Group operates a New York State Certified Basic Life Support ambulance. Medivac services are available to BNL via the Suffolk County Police Department. Additionally the Fire/Rescue Group has two 1500 GPM "Class A" Pumpers, one Rescue Vehicle for initial hazardous material incident response and heavy rescue operation, and one Incident Command Vehicle.

The single Fire Station is located on the west side of the BNL Site. Response time to the most remote section of the BNL Site is less than eight minutes. Response time to the CFN is estimated at 5 minutes.

BNL participates in the Suffolk County Mutual Aid Agreement. This allows the resources from over 130 departments to assist BNL. BNL is also a member of the Town of Brookhaven Foam Bank. BNL has a mutual aid agreement for hazardous material incidents with the Town of Brookhaven and Stonybrook University.

8.8 Fire Apparatus Accessibility

Fire apparatus accessibility is adequate for the facility. Current parking lot configurations and front entrance drop off allow access by apparatus in the event of an emergency.

8.9 Security Considerations Related to Fire Protection

The facility will have security measures to restrict access, including the use of card readers. Provisions will be made for Fire/Rescue access via card reader programming, provision of master key, or installation of interlocked crash doors.

9 LIFE SAFETY CONSIDERATIONS

Major life safety considerations for this facility include the following components; means of egress components and capacity, number and arrangement of the means of egress, travel distances to exits, discharge from the exits, and emergency lighting and marking of the means of egress.

This building is constructed to comply with the requirements the 2002 edition of BCNYS and the 2003 editions of the National Life Safety Code (NFPA 101) and NFPA 5000.

For the below analysis we will assume that the Clean Room Laboratory Suite will be built to general laboratory space.

9.1 Occupancy Load Factor and Calculations

The following table summarizes the occupancy load calculations based on both the BCNYS Table 1003.2.2.2 and NFPA 101 Table 7.3.1.2.

Location	Occupancy Load Factor (per person)		Area (feet)	BCNYS Load Calculations		NFPA Load Calculations	
	BCNYS	NFPA		Floor 1	Floor 2	Floor 1	Floor 2
Level 1: General Offices, Labs, Conference Rooms	100 gross	100 gross	38,326	383		383	
Level 1: Clean Room Laboratory Suite	100 gross	100 gross	5,024	51		51	
Level 1: Chemical Waste Storage, Toxic and Corrosive Storage, Pyrophoric Bunker	0	0	328	0		0	
Level 1: Flammable Storage	0	0	100	0		0	
Level 1: Building Services, Main Electrical	300 gross	0	7,717	26		0	
Level 2: General Offices, Conference Rooms	100 gross	100 gross	21,067		211		211
Level 2: Lab B3 Mechanical Room	300 gross	100 gross	5,024		17		50
Level 2: Mechanical	300	0	16,019		54		0
Level 2: Seminar Rooms	15 net	15 net	1,274		85		85
		TOTAL	94,500	485	367	434	346

9.2 Means of Egress

The means of egress for the CFN meets the present code requirements for number and arrangement of exits, capacity of exits, travel distance, common path of travel, dead ends, and security considerations related to egress. The following subsections provide the egress detail for the building.

9.2.1 Number and Arrangement of Exits

On level 1 there are eight exterior doors that are labeled as exits leading to the exterior of the building. The Clean Room Suite has two 36 inch doors. Fire rated stairs 2 & 4, serving both level 1 and 2, have 36 inch interior doors and 42 inch exterior doors. One exit leads out onto the loading dock and has a total width of 72 inches. Another is located on the southwest side of the building and has a total width

of 72 inches. The last one on the northeast side of the building and has a 42 inch door. The 8 foot diameter revolving door and the 48 inch clear width side door in the lobby area are not calculated in the exit route assessment.

There are three horizontal interior exits in the one hour rated egress corridors separating the Clean Room Suite from the rest of level 1.

9.2.2 Capacity of Exits

Based on the occupancy load calculations shown above and the available exit widths on level 1 and level 2 the CFN exit capacity will exceed the occupant loading required by BCNYS (Table 1003.2.3) and NFPA 101 (Table 7.3.3.1) for stairways, corridors, and other egress components in a fully sprinklered facility.

9.2.3 Travel Distance

The CFN building egress paths does not exceed the BCNYS and NFPA 101 travel distance limitations. BCNYS (Table 1004.2.4) limits egress travel distance to 250 feet in these types of sprinklered occupancies. NFPA 101 (Table 40.2.6) limits egress travel distance to 250 feet in these types of sprinklered occupancies.

9.2.4 Common Path of Travel

The CFN building does not exceed the common path of travel distance limits of BCNYS and NFPA 101. BCNYS 1004.2.5(1) limits the common path of travel distance to a maximum of 75 feet in these types of sprinklered occupancies. NFPA 101 (Table 40.2.5) limits common path of travel distance to 100 feet in these types of sprinklered occupancies.

9.2.5 Dead Ends

Dead end corridors in the CFN building do not exceed the distance limitations of NFPA 101 and BCNYS. NFPA 101 (Table 40.2.5) limits and the Fire Code of New York State (FCNYS) (Table 1010.17.2) limits the length to be a maximum of 50 feet in these types of sprinklered occupancies.

9.3 Barriers

9.3.1 Occupancy Separations

The occupancy separations in this building conforms to the requirements of BCNYS (Table 302.3.3) and NFPA 101 Table (6.1.14.4.1) for a fully sprinklered facility.

9.3.2 Separation of Means of Egress

All the buildings comply with the separations of means of egress as defined by the BCNYS (Table 1005.3.3) and NFPA 101 (7.1.3.1).

9.3.3 Vertical Opening Barriers

Shaft enclosures, fire dampers for duct penetrations, and floor opening protection as required by BCNYS and NFPA will be provided in the building.

9.4 Exit Signs and Emergency lighting

Placement of exit signs this building meet NFPA 101 and BCNYS “1003.2.10.”
Illumination of exit signs will meet NFPA 101 “40.2.8” and BCNYS “1003.2.10.4.

Emergency lighting of all means of egress via conventional lighting fixtures is provided and meets BCNYS “1003.2.11” and NFPA 101 “40.2.8.”

The exit signs and emergency lighting is connected to the centralized emergency generator.

9.5 Fire Protection Systems Required By Code

Normally this section describes the difference between the installed and required Fire Protection Systems by the latest codes. This FHA recognizes that this building has been built based on the latest codes.

9.6 Operational Requirements That Are Required By Code

There is one specific operational requirement of the facility that is required by code. The use of pyrophoric materials in experiments must be shut off and not moved within the building during all periods of sprinkler system impairments. The sprinklers, fire detection, and the life safety systems will be monitored and controlled by the BNL impairment system during maintenance periods to minimize outage time. Plant

Engineering and Operations are required to document the procedure for shutting off and restricted movement of Pyrophoric materials in the building during all sprinkler system impairments. (2007-735-01)

10 Appendix A – Resolutions to December 2004 Fire Hazard Analysis Review Comments

The following are the responses submitted by Martin Fallier regarding the design comments from the December 2004 Fire Hazard Analysis.

2004-735-01. The Clean Room Laboratory Suite will be defined as “Business Occupancy” by the Building Code of New York State (BCNYS) and as “Industrial, General Purpose” by National Fire Protection Association (NFPA). If this area in the future needed to be reclassified as “H-5” occupancy per BCNYS in order to use the types and quantities of flammable gases associated with Clean Rooms then a redesign of the space will be required to address both BCNYS and NFPA Standard 318 “Standard for the Protection of Semiconductor Fabrication Facilities,” requirements:

[Comment Resolution – Although the proposed use of the clean room does not require H-5 occupancy, the CFN design has already incorporated all architectural and emergency power features required for H-5 occupancy. If it is later determined that H-5 occupancy is desired, the remaining requirements (HSSD, gas monitoring and gas cabinets) can be added as change order with minimal impact to on-going construction or operational activities]

2004-735-02. Vital Record backup procedures should be verified for the vital records being generated by the experiments to make sure it conforms to BNL subject area.

[Comment Resolution – Requirements for records management will be addressed as part of the operating plan for the CFN]

11 Appendix B – Lightning Risk Calculation

EXPECTED LIGHTNING STROKE FREQUENCY FROM NFPA 780 APPENDIX H

$$N_d = (N_g)(A_e)(C_1)$$

N_d = **0.0127** = yearly average flash density in the region where the structure is located

(N_g) = **2.0** = the yearly lightning strike frequency to the structure

(C_1) = **0.25** = the environmental coefficient

(A_e) = **0.02533315** = the equivalent collective area of the structure in km2 from calculation below

Length (L)	**284**	Feet
Width (W)	**200**	Feet
Height (H)	**50**	Feet

Figure H.4.2(a) Results 0.02533315 sq. km

Figure H.4.2(b) Results 0.00656674 sq. km

Assume

0.25

Table H.4.3 Determination of Environmental Coefficient C_1

Relative Structure Location	C_1
Structure located within a space containing structures or trees of the same height or taller within a distance of $3H$	0.25
Structure surrounded by smaller structures within a distance of $3H$	0.5
Isolated structure, no other structures located within a distance of $3H$	1
Isolated structure on a hilltop	2

Figure H.4.2(a) Calculation of the equivalent collective area for a rectangular structure.

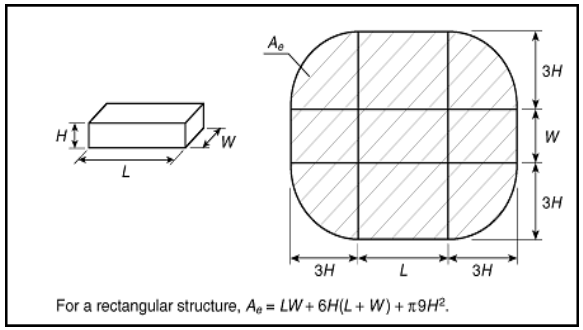
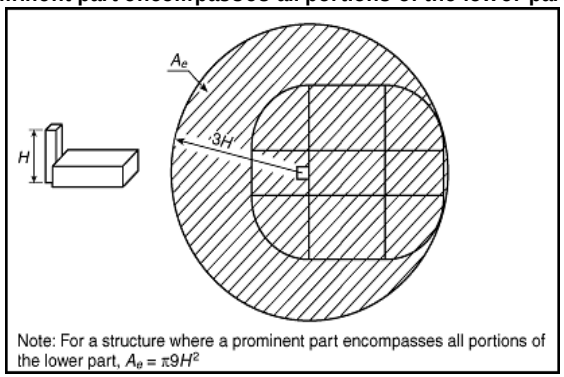


Figure H.4.2(b) Calculation of the equivalent collective area for a structure where a prominent part encompasses all portions of the lower part of the structure.



= input required

Lightning Risk Calculation cont.

TOLERABLE LIGHTNING FREQUENCY FROM NFPA 780 APPENDIX H

$$N_c = \frac{1.5 \times 10^{-3}}{C}$$

where $C = (C_2)(C_3)(C_4)(C_5)$.

N_c = **0.0003**

= input required

Assume **0.5**

C_2 — Structural Coefficients			
	Roof		
Structure	**Metal**	**Nonmetallic**	**Flammable**
Metal	0.5	1.0	2.0
Nonmetallic	1.0	1.0	2.5
Flammable	2.0	2.5	3.0

Assume **2.0**

Structure Contents	C_3
Low value and nonflammable	0.5
Standard value and nonflammable	1.0
High value, moderate flammability	2.0
Exceptional value, flammable, computer or electronics	3.0
Exceptional value, irreplaceable cultural items	4.0

Assume **1.0**

Structure Occupancy	C_4
Unoccupied	0.5
Normally Occupied	1.0
Difficult to evacuate or risk of panic	3.0

Assume **5.0**

Lightning Consequence	C_5
Continuity of facility services not required, no environmental impact	1.0
Continuity of facility services required, no environmental impact	5.0
Consequences to the environment	10.0